CLAIMS

1. A method of forming pancreatic β cells from mesenchymal cells which comprises subjecting mammal-derived mesenchymal cells to at least one step selected from the following steps (a) to (e):

a) the step of proliferating mesenchymal cells obtained from a mammalian sample and capable of differentiating into pancreatic β cells;

b) the step of selecting and isolating those mesenchymal cells which are capable of differentiating into pancreatic β cells from among mesenchymal cells obtained from a mammalian sample or from among the mesenchymal cells obtained in step a) using an antibody or antibodies capable of binding to a cell membrane antigen;

c) the step of cultivating the mesenchymal cells capable of differentiating into pancreatic β cells as obtained in step a) or b) or cells including such mesenchymal cells in an adhesion molecule/extracellular matrix-coated reaction vessel which enables the cells to contact with the adhesion molecules/extracellular matrix;

d) the step of cultivating the mesenchymal cells capable of differentiating into pancreatic β cells as obtained in step a), b) or c) or cells including such mesenchymal cells in contact with a pancreatic β cell-forming agent; and

e) the step of selecting and separating the pancreatic β cells obtained in the step c) or d) using a gene specifically expressed

in pancreatic β cells as a selective marker.

2. A method of forming pancreatic β cells from mesenchymal cells as defined in Claim 1, wherein the mesenchymal cells are obtained from bone marrow, muscle, pancreas, liver, small intestine, large intestine, kidney, subcutaneous tissue, endometrium, blood, cord blood or placenta.

3. A method of forming pancreatic β cells from mesenchymal cells as defined in Claim 1 or 2, wherein the selection of mesenchymal cells in step b) is carried out using a CD140-positive antibody.

4. A method of forming pancreatic β cells from mesenchymal cells as defined in any of Claims 1 to 3, wherein, in step e), the gene specifically expressed in pancreatic β cells is the insulin gene.

5. A method of forming pancreatic β cells from mesenchymal cells as defined in any of Claims 1 to 4, wherein, in step d), the pancreatic β cell-forming agent comprises at least one member selected from the group consisting of cytokines, physiologically active substances, transcription factors and adhesion molecules/extracellular matrices.

6. A method of forming pancreatic β cells from mesenchymal cells as defined in Claim 5, wherein the cytokine selected comprises at least one member selected from the group consisting of hepatocyte growth factor (HGF), fibroblast growth factor (bFGF)/FGF-2, insulin, transferrin, heparin-binding EGF, gastrin, TGF-β, insulin-like growth factor (IGF-1), parathyroid hormone-related proteins (PTHrP), growth hormone, prolactin, placental lactogen, glucagon-like peptide-1, exendin-4 and KGF (keratinocyte growth factor).

7. A method of forming pancreatic β cells from mesenchymal cells as defined in Claim 5, wherein the physiologically active substance selected comprises at least one member selected from the group consisting of nicotinamide, betacellulin, activin A, progesterone, putrescine and selenium.

8. A method of forming pancreatic β cells from mesenchymal cells as defined in Claim 5, wherein the transcription factor selected comprises at least one member selected from the group consisting of PTF1a/PTF-P48, Isl-1, Pdx-1/IPF-1, Beta2/neuroD, ngn3, PAX-6, PAX-4, Hlxb-9, Nkx2.2, Nkx6.1, HNF1α, HNF1β and HNF4α.

9. A method of forming pancreatic β cells from mesenchymal cells as defined in Claim 5, wherein the adhesion molecule/extracellular matrix selected comprises at least one

member selected from the group consisting of gelatin, laminin, collagen, agarose, fibronectin and ornithine.

10. A pancreatic β cell-forming agent for use in the method as defined in any of Claims 1 to 9 which comprises, as an active ingredient, at least one member selected from the group consisting of cytokines, physiologically active substances, transcription factors and adhesion molecules/extracellular matrices.

11. A pancreatic β cell-forming agent as defined in Claim 10, wherein the cytokine selected comprises at least one member selected from the group consisting of hepatocyte growth factor (HGF), fibroblast growth factor (bFGF)/FGF-2, insulin, transferrin, heparin-binding EGF, gastrin, TGF-β, insulin-like growth factor (IGF-1), parathyroid hormone-related proteins (PTHrP), growth hormone, prolactin, placental lactogen, glucagon-like peptide-1, exendin-4 and KGF.

12. A pancreatic β cell-forming agent as defined in Claim 10, wherein the physiologically active substance selected comprises at least one member selected from the group consisting of nicotinamide, betacellulin, activin A, progesterone, putrescine and selenium.

13. A pancreatic β cell-forming agent as defined in Claim 10,

wherein the transcription factor selected comprises at least one member selected from the group consisting of PTF1a/PTF-P48, Isl-1, Pdx-1/IPF-1, Beta2/neuroD, ngn3, PAX-6, PAX-4, Hlxb-9, Nkx2.2, Nkx6.1, HNF1α, HNF1β and HNF4α.

14. A pancreatic β cell-forming agent as defined in Claim 10, wherein the adhesion molecule/extracellular matrix selected comprises at least one member selected from the group consisting of gelatin, laminin, collagen, agarose, fibronectin and ornithine.

15. A method of screening candidate substances promoting the formation of pancreatic β cells from mesenchymal cells which comprises causing the formation of pancreatic β cells from mesenchymal cells according to the method as defined in Claim 1 in the presence of each candidate substance and selecting a candidate substance showing a pancreatic β cell formation-promoting effect in comparison with pancreatic β cells formed in the absence of the candidate substance.

16. A method of screening candidate substances promoting the formation of pancreatic β cells from mesenchymal cells as defined in Claim 15, wherein the mesenchymal cells are obtained from bone marrow, muscle, pancreas, liver, small intestine, large intestine, kidney, subcutaneous tissue, endometrium, blood, cord blood or placenta.

17. A method of screening candidate substances promoting the formation of pancreatic β cells from mesenchymal cells as defined in Claim 15 or 16, wherein the selection of mesenchymal cells in step b) is carried out using a CD140-positive antibody.

18. A method of screening candidate substances promoting the formation of pancreatic β cells from mesenchymal cells as defined in any of Claims 15 to 17, wherein, in step e), the gene specifically expressed in pancreatic β cells is the insulin gene.

19. A method of screening candidate substances promoting the formation of pancreatic β cells from mesenchymal cells as defined in any of Claims 15 to 18, wherein, in step d), the pancreatic β cell-forming agent comprises at least one member selected from the group consisting of cytokines, physiologically active substances, transcription factors and adhesion molecules/extracellular matrices.

20. A method of screening candidate substances promoting the formation of pancreatic β cells from mesenchymal cells as defined in Claim 19, wherein the cytokine selected comprises at least one member selected from the group consisting of hepatocyte growth factor (HGF), fibroblast growth factor (bFGF)/FGF-2, insulin, transferrin, heparin-binding EGF, gastrin, TGF-β, insulin-like

growth factor (IGF-1), parathyroid hormone-related proteins (PTHrP), growth hormone, prolactin, placental lactogen, glucagon-like peptide-1, exendin-4 and KGF.

21. A method of screening candidate substances promoting the formation of pancreatic β cells from mesenchymal cells as defined in Claim 19, wherein the physiologically active substance selected comprises at least one member selected from the group consisting of nicotinamide, betacellulin, activin A, progesterone, putrescine and selenium.

22. A method of screening candidate substances promoting the formation of pancreatic β cells from mesenchymal cells as defined in Claim 19, wherein the transcription factor selected comprises at least one member selected from the group consisting of PTF1a/PTF-P48, Isl-1, Pdx-1/IPF-1, Beta2/neuroD, ngn3, PAX-6, PAX-4, Hlxb-9, Nkx2.2, Nkx6.1, HNF1α, HNF1β and HNF4α.

23. A method of screening candidate compounds promoting the formation of pancreatic β cells from mesenchymal cells as defined in Claim 19, wherein the adhesion molecule/extracellular matrix selected comprises at least one member selected from the group consisting of gelatin, laminin, collagen, agarose, fibronectin and ornithine.

24. A method of screening candidate substances promoting the formation of pancreatic β cells from mesenchymal cells as defined in any of Claims 15 to 23, wherein the candidate substance is a cultivation-derived composition.

25. A substance capable of promoting the formation of pancreatic β cells from mesenchymal cells as obtained by the method of screening candidate compounds promoting the formation of pancreatic β cells from mesenchymal cells as defined in any of Claims 15 to 24.

26. A method for treating an impaired glucose tolerance-due disease of a patient which comprises administering an effective amount of the pancreatic β cells obtained by the method as defined in any of Claims 1 to 9 to the patient.

27. A therapeutic agent for an impaired glucose tolerance-due disease which comprises, as an active ingredient, the pancreatic β cells obtainable by the method as defined in any of Claims 1 to 9.

28. A method of causing differentiation into insulin-secreting cells which comprises scattering cells capable of differentiating into insulin-secreting cells on the layer of mesenchymal cells as obtained by monolayer culture on a culture dish and carrying out

the cocultivation thereof.

29. A method of causing differentiation into insulin-secreting cells by cocultivation as defined in Claim 28, wherein the cells capable of differentiating into insulin-secreting cell comprise at least one member selected from the group consisting of embryonic stem cells, pancreatic stem cells, small intestinal epithelial stem cells, liver-derived stem cells and amniotic cells.